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EXPERT SYSTEM TO DIAGNOSE COW DISEASE USING WEBSITE-BASED DEMPSTER-SHAFER ALGORITHM

Mufa'at Hadi Rosid[1)], Muhamad Fuat Asnawi[2) *], Nur Hasanah[3)]
[1,2,3)] Universitas Sains Al-Qur'an, Indonesia
[1)] mufaathadirosid@gmail.com, [2)]fuatasnawi@unsiq.ac.id, [3)]nurhasanah@unsiq.ac.id

*fuatasnawi@unsiq.ac.id

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Abstract: Cows are one of the livestock whose existence can meet various kinds of human needs because they are the main producer of animal protein such as meat or milk. However, there are problems that cause failure in running a cattle farm. One of the problems is the health factor of the cattle which is disturbed due to a disease. Limited knowledge and livestock health workers become an obstacle for cattle breeders in analyzing the possibility of disease affecting cattle based on the symptoms that appear. For this reason, an expert system was built that can diagnose cow disease based on a website which can later be an alternative when someone has limited access to experts to diagnose the disease he is suffering from. The dempster-shafer algorithm was chosen because it is able to provide certainty in performing diagnostic calculations. From the results of this study, an expert system for diagnosing cattle disease has been developed using the PHP programming language which can implement the algorithm and can run well, as evidenced by passing the testing phase using the black box test method and also successfully passing the accuracy test with experts. with a percentage of 86.67%.

Keywords: Expert System, Bovine Disease, Dempster-Shafer, Website

1. INTRODUCTION

Indonesia is an agricultural country with a fairly large population and has considerable potential for livestock, especially beef cattle and dairy cattle. Cows are one of the livestock whose existence can meet various kinds of human needs because they are the main producer of animal protein such as meat or milk. However, there are several problems that arise in cattle (Prasetyo & Wahyudi, 2019). One of the factors causing the failure to run a cattle farm is the emergence of various diseases that attack it. The emergence of disease disorders in cattle is a risk that must always be anticipated (Huda & Hadi, 2020). One of the most important things in handling the risk of disease that may strike is to periodically observe the health condition of the cows, and also make special observations of cows that have shown a decline in their health condition (Akhyari et al., 2022).. According to Mr. Hersi, as a former employee of the Watumalang District livestock service and also as a livestock nurse, cattle breeders, especially in the Wonoroto Village, Watumalang District, Wonosobo Regency, still have problems in carrying out early disease detection. This obstacle is based on a lack of knowledge about the disease that attacks based on the symptoms it causes and how to handle it. Another obstacle is the limited number of experts and access to experts which sometimes cannot be done directly.

Expert systems are part of artificial intelligence which has special abilities, namely adopting knowledge from humans into the system to solve existing problem conditions (Novita. E et al., 2020). An expert system is a decision-making system capable of achieving a level of performance that is comparable to experts in their field.

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Expert systems contain knowledge, facts, and reasoning techniques that can only be solved by experts in their respective fields (Ramadhanu & Gusrianto, 2019).

One of the proposed methods for use in this expert system is the Dempster-Shafer Algorithm. This algorithm has the advantage of dealing with uncertainties and information conflicts that may arise in the decision-making process. By effectively combining information from multiple sources, these algorithms can provide more accurate and reliable results. In presenting this expert system practically, the use of a website-based platform was chosen as the ideal solution. With a web-based basis, information and access to the system can be easily accessed by breeders or parties who need it, without being limited by geographical boundaries. This ease of access is expected to increase efficiency in handling diseases in cattle and in the end, will have a positive impact on the productivity and welfare of farmers (Rosana et al., 2020).

In addition, this research also aims to present a solution that is more accessible through a website-based platform, so that it can be used by various parties without technical problems (Aceng, 2020). Thus, this research is expected to contribute to the development of technology in the field of animal health, especially in efforts to prevent and control disease in cattle. Through the integration of the Dempster-Shafer Algorithm and a website-based platform, it is hoped that this expert system can become a useful tool in supporting farmers and practitioners in the livestock sector in facing the challenges of diagnosing diseases in cattle. The purpose of this research is to develop an expert system that can assist in the process of diagnosing diseases in cattle using the Dempster-Shafer Algorithm as a basis for decision making.

2. METHOD

This research was conducted using the methods of observation, interviews, data collection studies with Mr. Hersi Yogo as a former employee of the Watumalang District livestock service and also as a livestock orderly. The research step is to look for disease data tables, symptoms and give weights to disease and symptom data. System requirements analysis is carried out to accommodate according to the desired results. System design is used after knowing the system requirements. System design using charts and diagrams. The application of the algorithm is carried out in designing the system and implementation is carried out using a website-based information system (Anggraini et al., 2020).

3. RESULT

Table 1. Disease Data, Symptoms, and Weight Values

No	Disease	Symptom	Weight
1	Foot and mouth disease	Frothing mouth	0,75
		Tongue and lips with red or white patches	0,75
		Decreased appetite	0,4
		Weight loss	0,4
		Get rid of pus between the nails	0,85
		The nails are loose	0,85
		Cows are hard to stand	0,65
2	Scabies	Appearance of white spots on the ears, back and face	0,79
		Dull fur	0,75
3	Cough	Decreased appetite	0,55
		Coughs	0,75
		Hard to breath	0,6
		Cows look thinner	0,4
4	Bloating	Decreased appetite	0,4
		Cows are mostly silent	0,4
		Body temperature drops	0,6
		Dull fur	0,4
		Stomach size looks bigger	0,75
5	Septicaemia Epizootica	Cows snore excessively	0,7
		Body temperature rises	0,55
		Presence of a rather hard lump (usually in the right jaw)	0,76

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6	Anthrax	Decreased appetite	0,4
		Body temperature rises	0,5
		The cow staggered and trembled	0,55
		There is blood coming out of the nostrils, mouth, and rectum	0,8
		Urine mixed with blood	0,86
7	Surra	Decreased appetite	0,3
		Cows circling acting like mad cows	0,84
		The cow looks stressed	0,4
		Cows get tired easily	0,55
8	Worms	Decreased appetite	0,7
		Cows look thinner	0,5
		Dull fur	0,55
		Diarrhea	0,7
		Dirty anus	0,6
9	Cataract	Decreased appetite	0,45
		Body temperature rises	0,55
		A cow's eye secretes dirt which eventually causes cloudiness in the cornea	0,75
		The condition of the eye which was initially reddish then looks white	0,84
		Saliva	0,4
10	Fever	Decreased appetite	0,5
		Body temperature rises	0,8
		Cow shivers	0,76
		Cow limp and lethargic	0,65
		Decreased appetite	0,45
		Body temperature rises	0,6
		The udder is swollen and hot	0,84
		Cows will be in pain when any udder is touched	0,75
		Does not secrete milk for dairy cows and lactating cows	0,76

System requirements analysis is a stage of the system development method to find out the requirements required by the system being built. The system requirements needed include: 1)Login page for admin, 2)Add new admin page for admin, 3)Change password page for admin, 4)Add symptom data page for admin, 5)Change symptom page for admin, 6)Remove symptom for admin, 7)Add disease data page and its solutions for admin, 8)Disease data editing page and its solutions for the admin, 9)Delete disease data and its solutions for admin, 10)Logout page for admin, 11)Diagnostics page for admin and guest (Setiyani, 2021).

System Design

Diagnostic Flowchart

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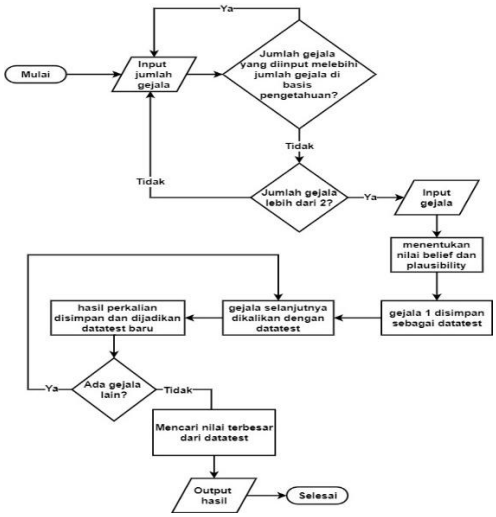

Fig 1, Flow Chart Diagnosa

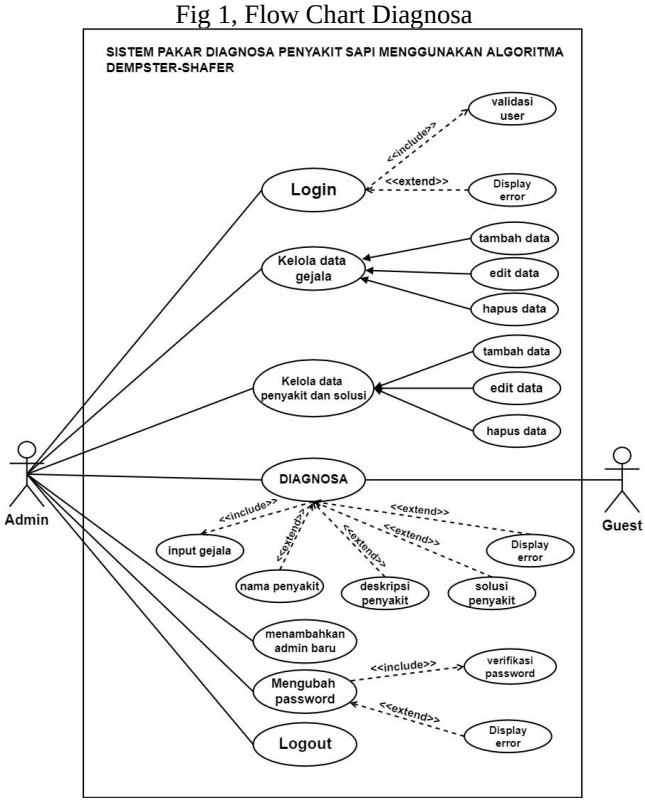

Fig 2. Use Case Diagram

Application of the Dempster-Shafer Algorithm
It is known that the user enters 4 symptoms, among others, frothing at the mouth, the cow looks thinner, pus oozes between the nails, dull fur. Then in the dempster-shafer calculation using the formula: (Milzam et al., 2018)

$$m3\ (Z)\ = \frac{\sum X \cap Y = Z\ m1(X).m2(Y)}{1 - \sum X \cap Y = \emptyset\ m1(X).m2(Y)}$$

Clean Energy and Smart Technology
Volume 02, Number 01, October 2023
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The first step is to find the value of belief and plausibility of each symptom. The belief values given by experts will be combined by finding the average value as the final belief value for symptoms for each disease (Retta et al., 2019). The next step is to find the plausibility value by means of 1 – belief from symptoms. After looking for the value of belief and plausibility it will produce the data rule as follows:

Table 2. Rule for Selective Symptoms

No	Gejala	Kode Penyakit	*Belief*	*Plausibility*
1	Mulut berbuih	PMK	0,75	0,25
2	Sapi terlihat lebih kurus	BTK, CC	$\frac{0,4+0,5}{2}=0,45$	0,55
3	Mengeluarkan nanah di sela-sela kuku	PMK	0,85	0,15
4	Bulu kusam	KDS, KBG, CC	$\frac{0,75+0,4}{2}=0,57$	0,43

The next step is to multiply symptom 1 (M1) and symptom 2 (M2):
Symptom 1: Mouth foaming {PMK}, Belief = 0.75, Plausibility = 0.25.
Symptom 2: Cows look thinner {BTK, CC}, Belief = 0.45, Plausibility = 0.55.

Table 3. Multiplication of Symptoms 1 and Symptoms 2

		M2 {BTK, CC}	0,45	θ	0,55
M1 {PMK}	0,75	{}	0,338	{PMK}	0,413
M1 {θ}	0,25	{BTK, CC}	0,113	{θ}	0,138

$$\text{M3}\{\text{PMK}\}=\frac{0,413}{1-0,338}=\frac{0,413}{0,662}=0,624$$

$$\text{M3}\{\text{BTK, CC}\}=\frac{0,113}{1-0,338}=\frac{0,133}{0,662}=0,171$$

$$\text{M3}\{\theta\}=\frac{0,138}{1-0,338}=\frac{0,138}{0,662}=0,208$$

The results of the calculation of symptoms 1 and 2 find new facts, namely:
M3 {PMK} = 0.624
M3 {BTK, CC} = 0.171
M3 {θ} = 0.208
The next step is the multiplication between M3 and symptom 3 (M4):
Symptom 3 : Pus out between the nails {PMK}, Belief = 0.85, Plausibility = 0.15.

Tabel 4. Multiplication M3 and Symptom 3

		M4 {PMK}	0,85	M4 θ	0,15
M3 {PMK}	0,624	{PMK}	0,530	{PMK}	0,094
M3 {BTK, CC}	0,171	{}	0,145	{BTK, CC}	0,026
M3 {θ}	0,208	{PMK}	0,177	{θ}	0,031

$$\text{M5}\{\text{PMK}\}=\frac{0,530+0,094+0,177}{1-0,145}=\frac{0,801}{0,855}=0,937$$

$$\text{M5}\{\text{BTK, CC}\}=\frac{0,026}{1-0,145}=\frac{0,026}{0,855}=0,030$$

$$\text{M5}\{\theta\}=\frac{0,031}{1-0,145}=\frac{0,031}{0,855}=0,037$$

Clean Energy and Smart Technology
Volume 02, Number 01, October 2023
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The results of the calculation of M3 and symptom 3 find new facts, namely:
M5 {PMK} = 0.937
M5 {BTK, CC} = 0.030
M5 {θ} = 0.037
The next step is the multiplication between M5 and symptom 4 (M6):
Symptom 4: Dull fur {KDS, KBG, CC}, Belief = 0.57, Plausibility = 0.43.

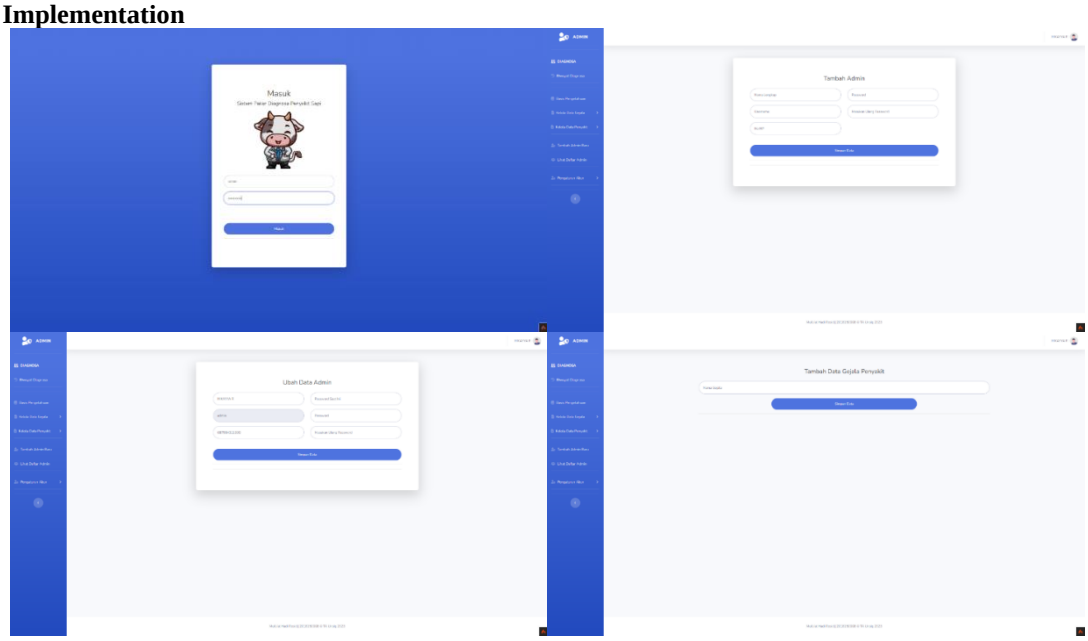
Table 5. Multiplication M5 and Symptom 4

		M6{KDS, KBG, CC}	0,57	M6 θ	0,43
M5 {PMK}	0,937	{}	0,534	{PMK}	0,403
M5{BTK, CC}	0,030	{CC}	0,017	{BTK, CC}	0,013
M5 {θ}	0,037	{KDS, KBG, CC}	0,021	{θ}	0,016

$$M7\{PMK\} = \frac{0,403}{1 - 0,536} = \frac{0,403}{0,466} = 0,856$$
$$M7\{CC\} = \frac{0,017}{1 - 0,536} = \frac{0,017}{0,466} = 0,037$$
$$M7\{BTK, CC\} = \frac{0,013}{1 - 0,536} = \frac{0,013}{0,466} = 0,028$$
$$M7\{KDS, KBG, CC\} = \frac{0,021}{1 - 0,536} = \frac{0,021}{0,466} = 0,045$$
$$M7\{\theta\} = \frac{0,016}{1 - 0,536} = \frac{0,016}{0,466} = 0,034$$

From the results of the dempster-shafer calculation above, it can be concluded that the final result of the diagnosis is FMD (Foot and Mouth Disease) with the largest density value of 0.856.

System Implementation



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Volume 02, Number 01, October 2023
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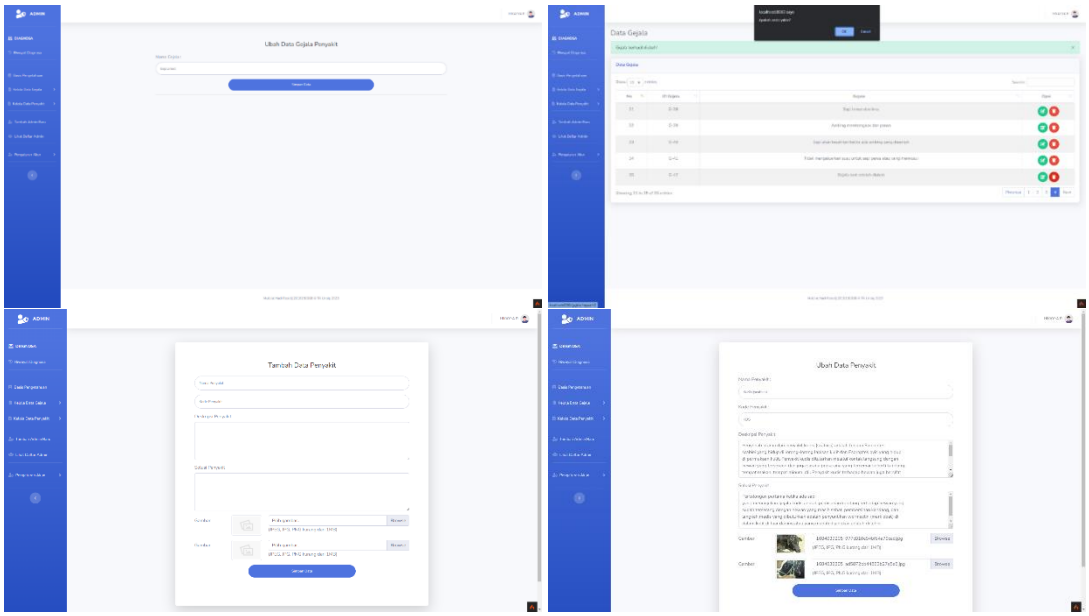

Fig 3. a)Login Page, b)Add New Admin Page, c)Change Password page, d)Add Symptom Data Page, e)Change Symptom Data Page, f)Delete Symptom Data page, g)Add Disease Data page, h)Change Disease i)Data Page

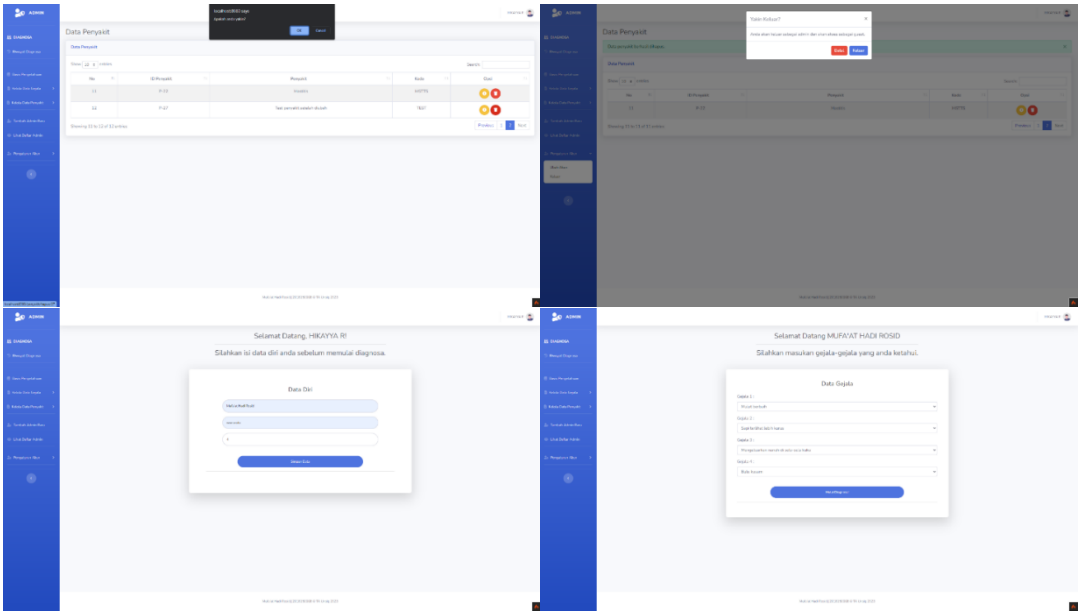

Fig 4. a)Delete Disease Data page, b)Logout page, c)Diagnostics page, d)Symptom Input Page

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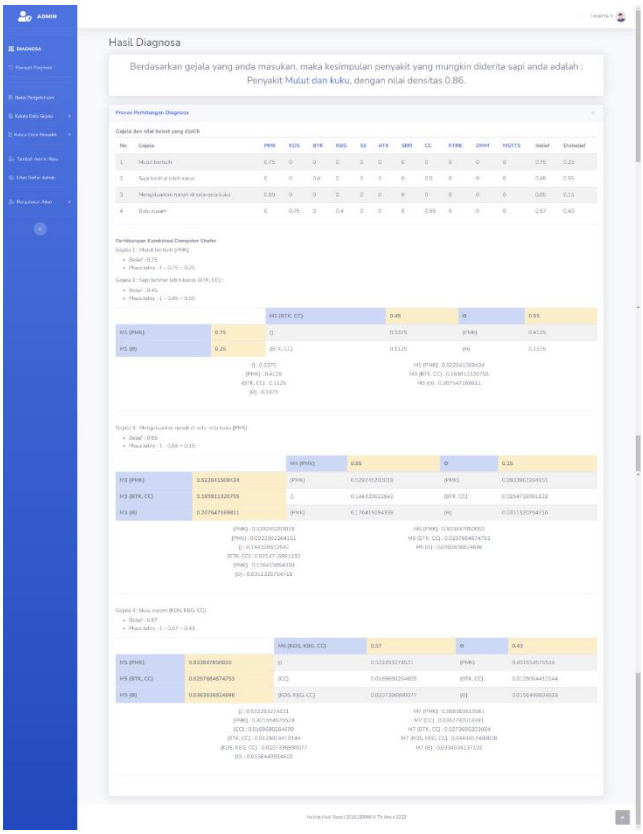

Fig 5. Diagnostic Results page

Accuracy Test

No	Symptom	System	Expert	Conclusion
1	a. Frothing mouth b. Decreased appetite c. Cows are mostly silent d. Cows are hard to stand	Foot and Mouth Disease (0.86)	Foot and Mouth Disease	In accordance
2	a. Decreased appetite b. Weight loss c. Diarrhea d. Dirty anus e. Dull fur	Worms (0.85)	Worms	In accordance
3	a. Weight loss b. Dull fur c. Cow limp and lethargic d. Cow shivers	Fever (0.78)	Fever	In accordance
4	a. Appearance of white spots on the ears, back or face b. Dull fur	Scabies (0.79)	Scabies	In accordance
5	a. Cows circling or acting like mad cows b. Cows get tired easily c. Decreased appetite d. Weight loss	Surra's disease (0.89)	Surra	In accordance

Clean Energy and Smart Technology
Volume 02, Number 01, October 2023
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6	a. Tongue and lips with red or white patches b. Decreased appetite c. Weight loss	Foot and Mouth Disease (0.85)	Foot and Mouth Disease	In accordance
7	a. Decreased appetite b. Body temperature rises c. The cow's eye secretes dirt which causes cloudiness in the cornea over time d. Saliva	Cataract Disease (0.85)	Cataract Disease	In accordance
8	a. There is blood coming out of the nostrils, mouth, rectum b. Urine mixed with blood c. Body temperature rises d. Cows are mostly silent e. Cows get tired easily	Anthrax Disease (0.95)	Anthrax disease	In accordance
9	a. Body temperature rises b. The udder is swollen and hot c. Cows will be in pain when any udder is touched d. Decreased appetite e. Cow limp and lethargic	Mastitis Disease (0.89)	Mastitis Disease	In accordance
10	a. Hard to breath b. Coughs c. Decreased appetite d. Cows look thinner	Cough (0.9)	Cough	In accordance
11	a. Decreased appetite b. Cows look thinner c. Hard to breath d. Body temperature rises	Cough (0.45)	Fever	It is not in accordance with
12	a. Body temperature rises b. Cattle snoring (snoring) excessively c. A rather hard lump in the jaw (usually on the right) d. Cow shivers	Septicaemia Epizootica (snoring) (0.75)	Septicemia Epizootica (snoring)	In accordance
13	a. Dull fur b. Body temperature drops c. Stomach size larger than normal	Bloating (0.9)	Bloating	In accordance
14	a. Decreased appetite b. Weight loss c. Dull fur d. Body temperature rises	Septicemia Epizootica (snoring), Anthrax, Cataracts, Fever, Mastitis (0.18)	Fever	It is not in accordance with
15	a. Dull fur b. Cow shivers c. Cow limp and lethargic d. Cows are mostly silent	Fever (0.73)	Fever	In accordance

Accuracy test aims to determine the level of conformity between the results of system diagnostics and expert diagnoses. This test was carried out using 15 examples of diagnostic cases. Where the results of the test are 13 cases giving valid results while 2 other cases are invalid. So the results obtained from the accuracy test are $\frac{13}{15} \times 100\% = 86.67\%$.

Clean Energy and Smart Technology
Volume 02, Number 01, October 2023
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4. CONCLUSION

The dempster-shafer algorithm can be applied to diagnose cow disease in overcoming uncertainty to analyze the disease suffered by their cows. The expert system for diagnosing cattle disease using the dempster-shafer algorithm that has been built has successfully implemented the algorithm and the system is running well as evidenced by successfully passing the black box trial stage and also passing the accuracy test with experts with a percentage of 86.87%. With this expert system, breeders can diagnose the diseases their cows are suffering from based on known symptoms. This expert system displays the results of the disease along with its description and solution.

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